JAPAN

EDICT OF GOVERNMENT

JIS Z 4334 (2005) (English): Reference sources for the calibration of surface contamination monitors -- Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters

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The citizens of a nation must honor the laws of the land.

Fukuzawa Yukichi

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JIS

JAPANESE
INDUSTRIAL
STANDARD

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JIS Z 4334 : 2005

(JEMIMA/JSA)

Reference sources for the calibration of surface contamination monitors — Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters

ICS 17.240

Reference number : JIS Z 4334 : 2005 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Electric Measuring Instruments Manufacturers' Association (JEMIMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS Z 4334 : 1992** is replaced with this Standard.

This revision has been made based on **ISO 8769**:1988 *Reference sources for the calibration of surface contamination monitors—Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters* for the purpose of making it easier to compare this Standard with International Standard; to prepare Japanese Industrial Standard conforming with International Standard; and to propose a draft of an International Standard which is based on Japanese Industrial Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

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Technical Committee on Testing and Measurement Technology

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Contents

Reference sources for the calibration of surface contamination monitors—Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 8769** *Reference sources for the calibration of surface contamination monitors—Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters* published in 1988 with some modifications of the technical contents.

The portions underlined with dots are the matters in which the contents of the original International Standard have been modified. A list of modifications with the explanations is given in Annex (informative).

1 Scope This Standard specifies the characteristics of reference sources of large area for the calibration of surface contamination monitors. This Standard relates to alpha-emitters and to beta-emitters of maximum beta energy greater than 0.15 MeV. It does not specify the procedures involved in the use of these reference sources for the calibration of surface contamination monitors.

Remarks 1 The calibration method of a radioactive surface contamination monitor using a standard source shall be based on **JIS Z 4504**.

2 The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21.**

ISO 8769:1988 *Reference sources for the calibration of surface contamination monitors — Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS Z 4001 *Glossary of terms used in nuclear energy*

Remarks : **ISO 921** *Nuclear energy — Vocabulary*, **IEC 60050-393** *International Electrotechnical Vocabulary—Chapter 393* and **IEC 60050-394** *International Electrotechnical Vocabulary —Chapter 394* are equivalent to the said standard.

JIS Z 4504 *Evaluation of radioactive surface contamination*

Remarks : ISO 7503-1:1988 *Evaluation of surface contamination—Part 1: Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters* is equivalent to the said standard.

JIS Z 8103 *Glossary of terms used in measurement*

3 **Definitions** For the purpose of this Standard, the definitions given in JIS Z 4001 and JIS Z 8103 and the following definitions apply.

a) **surface contamination monitors** general term of the apparatus which measures the radioactive contamination on goods or the surface of a human body like a survey meter for radioactive surface contamination, a hand and foot contamination monitor and a body surface contamination monitor

b) **surface emission rate** (of a source) number of particles of a given type above a given energy emerging from the face of the source or its window per unit time

c) **instrument efficiency** ratio between the instrument net reading (counts per unit time) and the surface emission rate of the source (particles emitted per unit time) in a specified geometry relative to a source (1)

Note (1) : The instrument efficiency depends on the energy of the radiations emitted by the source.

d) **source efficiency** ratio between the surface emission rate and the number of particles of the same type created or released within the source or its saturation layer thickness per unit time (2)

Note (2) : According to this definition, the efficiency of a source would be expected to be not more than 0.5; however, a contribution due to back-scattered particles can enhance this value considerably.

e) **uniformity** (of a surface in respect of a given property expressed as a measured quantity per unit area)

The uniformity shall be specified as the estimated standard deviation of measurements of the individual portions about the mean value for the whole surface as a percent of the mean value. The area of the portions shall be 10 cm^2 or less.

NOTES 1 Uniformity may be measured by inserting a masking plate between the source and the detector. The masking plate should have an aperture of appropriate size and should be thick enough to absorb particles of the maximum energy emitted.

2 As long as the uniformity of a source can be fully checked, a measuring instrument may be calibrated by using a part of source.

4 **Traceability of reference sources** The following scheme is proposed to ensure that working sources used in the field for the routine calibration of surface contamination monitors shall be related to national measurement standards via a clearly defined traceability chain using reference sources and transfer instruments. Reference sources shall be of two types:

a) Class 1: Reference source which shall have been calibrated directly in terms of surface emission rate at a national standards laboratory.

Information : The national standards laboratory about the radioactivity in Japan is National Institute of Advanced Industrial Science and Technology.

b) Class 2: Reference sources which shall have been calibrated in terms of surface emission rate on a reference transfer instrument the efficiency of which has been measured by calibration with a Class 1 reference source of the same radionuclide and of the same general construction using the same geometry.

Information : Under the traceability system of the Measurement Law in Japan, the standard source that the national standards laboratory calibrated by using a specified standard instrument is a Class 1 reference source, and the standard source that the accredited laboratory in this system calibrated by using its own specified secondary standard instrument is a Class 2 reference source.

The geometry for calibrating Class 2 reference source with a transfer instrument shall be the same as the geometry that calibrated a transfer instrument by a Class 1 reference source.

The surface emission rate of Class 1 reference sources would be measured by absolute methods, using, for example, a windowless gasflow proportional detector, or by using an instrument that has been calibrated using sources that have been measured absolutely. Moreover, the calibration method of a Class 1 reference source shall be specified if needed (3).

When performing the type approval test of a radioactive surface contamination monitor, a suitable Class 1 reference source or a Class 2 reference source is used. When calibrating a radioactive surface contamination monitor, a Class 1 reference source, a Class 2 reference source, or a working source is used.

Note (3) : It is likely that some countries would accept as valid a Class 1 reference source that had been certified by the national standards laboratory in other countries.

NOTE : The purpose of a working source is to calibrate radioactive surface contamination monitors in the field; they are not to be confused with check sources which are only intended to test that a monitor is operating.

The surface emission rate of the working source used to calibrate a radioactive surface contamination monitor is calibrated by using a transfer instrument and by carrying out comparison measurement to a Class 1 reference source or a Class 2 reference source.

Where the working source will be used either in a jig or under a particular geometry, the reference transfer instrument on which its emission rate is measured shall have been calibrated using a reference source under identical conditions and geometry;

alternatively, the working source shall be removable from the jig so that it can be measured in the usual way.

Where a high degree of accuracy is required, Class 1 or 2 reference sources may be used as working sources.

5 Characteristics, performance, and construction of standard sources

5.1 General specifications Reference standard sources may be of two kinds:

- Sources comprising an electrically conducting backing material with a given radionuclide deposited upon or incorporated into one face only; the thickness of the backing material shall be sufficient to prevent emission of the particulate radiation through the back of the source.
- Sources comprising a layer of material within which the radionuclide is uniformly distributed and the thickness of which is at least equal to the saturation layer thickness.

Reference standard sources shall be of adequate radiochemical purity.

NOTE : It is difficult to check for beta-emitting impurities. In the case of a radionuclide that emits gamma ray at the same time, the presence of impurities may be inferred from the detection of their associated photon radiation, if any, using a high-resolution spectrometer, with, for example, a Ge detector. It may also be possible to determine the residual maximum beta energy, E_{res} to detect beta-emitting impurities which have a maximum beta energy, E_{max} greater than the specified nuclide.

Source of maximum beta energy greater than or equal to 0.4 MeV shall have an efficiency greater than 0.25; those of maximum beta energy 0.15 or over to and excluding 0.4 MeV and alpha-emitting sources shall have an efficiency greater than 0.05.

5.2 Class 1 reference sources

5.2.1 General requirements Class 1 reference sources shall be plane sources comprising an electrically conducting backing material with radioactive material deposited upon or incorporated into one face in such a manner as to minimize source self-absorption (4).

Note (4) : A Class 1 reference source is intended to approximate as closely as practicably possible to an ideal "thin" source with respect to the activity itself. However, it is acknowledged that with alpha-emitters and low-energy beta-emitters, self-absorption will be far from negligible.

The active area shall be at least 100 cm^2; a recommended size is 10 cm × 15 cm.

These thicknesses are sufficient to eliminate emission through the back of the source. A list of recommended minimum backing thickness of commonly used materials is given in the table 1.

Sources shall be accompanied by a calibration certificate giving the following information:

a) nominal radioactivity and the reference date;

b) active area of source;

c) surface emission rate, its uncertainty and the reference date;

d) radionuclide and its half-life;

e) source identification number;

f) uniformity;

g) class of source.

Manufacturers may decide to give further information of help to the user.

Markings on the source itself shall indicate the radionuclide and the source identification number.

Table 1 Characteristics of the radionuclides for Class 1 reference sources

Radionuclide	Approximate half-life	Maximum energy	Minimum thickness of backing surface		
			Mass per unit area	Aluminium	Stainless steel
	years	keV	mg/cm^2	mm	mm
^{14}C	5 730	156	22	0.08	0.03
^{147}Pm	2.62	225	35	0.13	0.04
^{36}Cl	3×10^5	710	170	0.6	0.20
^{204}Tl	3.78	763	180	0.7	0.23
$^{90}Sr+^{90}Y$	28.5	2 274	850	3.1	1.1
$^{106}Ru+^{106}Rh$	1.01	3 540	1 300	4.8	1.7
^{241}Am	432.6	5 544	6	0.02	0.01

5.2.2 Activity and surface emission rate The activity of a Class 1 reference source of the preferred size needs to be such as to give a surface emission rate from 2 000 to 10 000 s^{-1} in order to optimize between background, statistical and deadtime errors.

The surface emission rate shall be measured by the national standards laboratory with an uncertainty which shall not exceed ± 3 % (5).

Note (5) : Uncertainty in this Standard shall be 1 standard deviation.

5.2.3 Uniformity The uniformity of a Class 1 reference source in terms of surface emission rate shall be better than ± 10 %.

5.2.4 Radionuclides Class 1 references sources should be prepared, if possible, from any of the following radionuclides (characteristics of these radionuclides are given in table 1):

a) alpha-emitter : ^{241}Am;

b) beta-emitters : ^{14}C, ^{147}Pm, ^{36}Cl or ^{204}Tl, $^{90}Sr + ^{90}Y$ (6);

c) other radionuclides as may be agreed upon from time to time by the national standards laboratory (if a source of higher beta energy is required, $^{106}Ru+^{106}Rh$ is suggested).

Note (6) : The use of filters with $^{90}Sr + ^{90}Y$ is not excluded. If only the higher beta energy ^{90}Y is required, a filter of 130 mg/cm^2 will be needed.

5.3 Class 2 reference sources

5.3.1 General requirements Class 2 reference sources shall comply with the same general requirements as specified for Class 1 reference sources.

5.3.2 Activity and surface emission rate The activity of a Class 2 reference source should be as required by the user. The surface emission rate shall be determined by means of a reference transfer instrument and shall be stated with an uncertainty not exceeding ± 6 %.

5.3.3 Uniformity The uniformity of a Class 2 reference source in terms of surface emission rate should be better than ± 10 %.

5.3.4 Radionuclides Class 2 reference sources shall be prepared from among the same radionuclides as provided for Class 1 reference sources.

5.4 Working sources

5.4.1 General requirements The detailed requirements specified for working sources shall be the responsibility of the user. In specifying working sources the following points need to be considered:

a) working sources shall be provided in a quantity and variety of sizes to meet the needs of the organization in respect of the routine calibration of its surface contamination monitors;

b) working sources shall be marked with the surface emission rate at a reference date, the radionuclide and the serial number. However, when a surface emission rate on a reference date cannot be marked on a source, it may be marked on a calibration certificate. If necessary, working sources shall be accompanied by a note detailing the geometry for which they have been calibrated, or detailing how to use the said working source to calibrate a radioactive surface contamination monitor.

c) working sources shall be sufficiently robust to withstand day-to-day handling;

d) working sources shall comply as far as possible with the requirements specified for reference sources.

5.4.2 Surface emission rate The surface emission rate of a working source should be as agreed between the user and the manufacturer. The surface emission rate shall have been measured on a reference transfer instrument that has been calibrated using a Class 1 or a Class 2 reference source of the same construction.

5.4.3 Uniformity The uniformity of a working source should preferably be the same as specified for a Class 2 reference source.

5.4.4 Radionuclides Working sources shall be prepared from such alpha- and beta-emitting radionuclides as may be required by the user. For example, in addition to the radionuclides specified in 5.2.4, ^{60}Co, ^{137}Cs, etc. are available.

6 Transfer instruments

6.1 Reference transfer instrument A reference transfer instrument needs to have an efficiency greater than 0.5 over the range of energies considered in this Standard.

It should be of such size that the variation in spatial response over a measurement area of 10 cm × 15 cm can safely be ignored.

Corrections shall be made for electronic dead time and the background counting rate.

The threshold for beta counting shall be set to correspond to a photon energy of 590 eV (0.1 times the energy of the KX line of Mn following the decay of ^{55}Fe). For alpha counting, the threshold should be set just above the electronic noise of the system.

The recommended type of reference transfer instrument is a commercially available large-area, gas-flow proportional detector stripped of all protective grills and provided with an electrically conducting window of maximum mass per unit area of 1 mg/cm^2 unsupported over the active area, together with a regulated gas supply, high-voltage supply, preamplifier, main amplifier, discriminator and detector.

6.2 Calibration A reference transfer instrument shall be calibrated both initially and at regular intervals during its working life. Calibration of a reference transfer instrument shall be the responsibility of the users.

Where beta-emitting radionuclides that are not specified in **b)** or **c)** of **5.2.4** are required as working sources, traceability may be maintained by interpolation of the transfer instrument efficiency. However, for beta-emitters of maximum energy less than 0.5 MeV where the efficiency of gas-flow proportional detector changes steeply as a function of energy, interpolation could lead to large errors and every effort should be made to obtain suitable Class 1 or 2 reference sources.

Annex (informative) Comparison table between JIS and the corresponding International Standard

JIS Z 4334:2005 *Reference sources for the calibration of surface contamination monitors— Beta-emitters (maximum beta energy greater than 0.15 MeV and alpha-emitters*			ISO 8769: 1988 *Reference sources for the calibration of surface contamination monitors— Beta-emitters (maximum beta energy greater than 0.15 MeV) and alpha-emitters*				
(I) Requirements in **JIS**		(II) International standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard, by clause Location of deviation: text Indication method: dotted underline		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
1 Scope	Reference source of large area to calibrate a radioactive surface contamination monitor — alpha emitters and beta emitters of maximum energy not less than 0.15 MeV	**ISO 8769**	1	Identical with **JIS**.	IDT	—	
2 Normative references	**JIS Z 4001** **JIS Z 4504** **JIS Z 8103**		2	**ISO 921**, **ISO 6980**, **ISO 7503-1**, **IEC 60050 (391)**, **IEC 60050 (392)** and **IEC 60325**	MOD /deletion /addition	**ISO 6980** and **IEC 60325** are deleted. **ISO 921**, **ISO 7503-1**, **IEC 60050 (393)**, and **IEC 60050 (394)** refer to the corresponding **JIS**.	They are deleted because there is no particular necessity of reference.
3 Definitions	A radioactive surface contamination monitor, surface emission rate, instrument efficiency, source efficiency and uniformity		3	activity, surface emission rate, saturation layer thickness, instrument efficiency, source efficiency, self-absorption, traceability, uncertainty and uniformity	MOD /deletion /addition	— Deleted terms from **ISO** Standard: activity, saturation layer thickness, self-absorption, traceability, and uncertainty. — Added term to **JIS**: radioactive surface contamination monitor.	Because the deleted terms are defined in **JIS Z 4001** and **JIS Z 8103** that were referred to and these contents are almost the same, they are deleted. The added term is slightly different from the content of term defined in **JIS Z 4001**, so it is added to avoid confusion.
4 Traceability of reference sources	Class 1 reference source Class 2 reference source		4	Identical with **JIS**.	IDT	—	
5 Characteristics, performance, and construction of standard sources			5	Identical with **JIS**.	IDT	—	
5.1 General specifications	Source construction Source efficiency		5.1	Identical with **JIS**.	IDT	—	

(I) Requirements in **JIS**		(II) International standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard, by clause Location of deviation: text Indication method: dotted underline		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
5.2 Class 1 reference sources			5.2	Identical with **JIS**.	IDT		
5.2.1 General requirements	Source construction and size Calibration certificate Marking of a source		5.2.1	Almost the same with **JIS**. However, the nominal radioactivity indicated in a calibration certificate is written as radioactivity.	MOD /deletion /addition	Radioactivity is deleted from items described in calibration certificates specified by **ISO** Standard. Nominal radioactivity is added to **JIS**.	**JIS** does not specify radioactivity calibration. So, radioactivity is deleted from described items. **JIS** additionally specifies nominal radioactivity that is necessary for actual radioactivity management. Addition will be proposed at the time of next revision of **ISO** Standard.
5.2.2 Activity and surface emission rate	Activity Surface emission rate		5.2.2	Almost the same with **JIS**.	MOD /deletion	**JIS** deletes the radioactivity calibration which **ISO** Standard has specified.	It is difficult to implement the radioactivity calibration specified in **ISO** Standard, and its necessity in the case of monitor calibration is low. So, deletion is made. Deletion will be proposed at the time of next revision of **ISO** Standard.
5.2.3 Uniformity	Uniformity of a surface emission rate		5.2.3	Identical with **JIS**.	IDT	—	
5.2.4 Radionuclides	The radionuclide used for a Class 1 reference source		5.2.4	Identical with **JIS**.	IDT	—	
5.3 Class 2 reference sources			5.3	Identical with **JIS**.	IDT	—	
5.3.1 General requirements	The same as that of a Class 1 reference source		5.3.1	Identical with **JIS**.	IDT	—	
5.3.2 Activity and surface emission rate	Activity Surface emission rate		5.3.2	Almost the same with **JIS**.	MOD /deletion	**JIS** deletes the radioactivity calibration which **ISO** Standard has specified.	It is difficult to implement the radioactivity calibration specified by **ISO** Standard. Its necessity in the case of monitor calibration is low. So, deletion is made. Deletion will be proposed at the time of next revision of **ISO** Standard.
5.3.3 Uniformity	Uniformity of a surface emission rate		5.3.3	Identical with **JIS**.	IDT	—	
5.3.4 Radionuclides	The radionuclide used for a Class 2 reference source		5.3.4	Identical with **JIS**.	IDT	—	

(I) Requirements in **JIS**		(II) International standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard, by clause Location of deviation: text Indication method: dotted underline		(V) Justification for the technical deviation be and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
5.4 Working sources			5.4	Identical with **JIS**.	IDT	—	
5.4.1 General requirements	The general requirements for working source		5.4.1	Almost the same with **JIS**.	MOD /addition	**JIS** deletes the relief provision for source marking where a surface emission rate on a date of record cannot be marked.	Marking of a surface emission rate on a source is sometimes difficult. The relief provision is added to **JIS**. Addition will be proposed at the time of next revision of **ISO** Standard.
5.4.2 Surface emission rate	Surface emission rate		5.4.2	Activity and a surface emission rate	MOD /deletion	**ISO** Standard specifies radioactivity calibration. **JIS** has no provision of radioactivity calibration.	It is difficult to implement the radioactivity calibration specified in **ISO** Standard, and its necessity in the case of monitor calibration is low. So, deletion is made. Deletion will be proposed at the time of next revision of **ISO** Standard.
5.4.3 Uniformity	Uniformity of a surface emission rate		5.4.3	Identical with **JIS**.	IDT	—	
5.4.4 Radionuclides	The radionuclide used for a working source		5.4.4	Almost the same with **JIS**.	MOD/ addition	^{60}Co, ^{137}Cs, etc.	In order to make **JIS** easy to understand, the radionuclides are added.
6. Trnasfer instruments			6	Identical with **JIS**.	IDT	—	
6.1 Reference transfer instrument	Specification of a transfer instrument		6.1	Identical with **JIS**.	IDT	—	
6.2 Calibration	Calibration of a transfer instrument		6.2	Identical with **JIS**.	IDT	—	

Designated degree of correspondence between **JIS** and International Standard: MOD

Remarks 1 Symbols in sub-columns of classification by clause in the above table indicate as follows:

— IDT : Identical in technical contents.

— MOD/deletion : Deletes specification item(s) and content(s) of International Standard.

— MOD/addition : Adds the specification item(s) or content(s) which are not included in International Standard.

2 Symbol in column of designated degree of correspondence between **JIS** and International Standard in the above table indicates as follows:

— MOD : Modifies International Standard.

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:

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